

REMARKS/ARGUMENTS

Claims 1 - 13 are pending in the application. Claims 1 and 6 have been amended. A new independent claim 13 has been added.

In the Office Action, the disclosure is objected to on the grounds that Page 2 comprises an informality. Applicants have submitted herewith an amendment to Page 2 to correct the informality thereon.

With further regard to the Office Action, claims 1 and 6 are objected to as comprising informalities and claim 1 is rejected under 35 U.S.C 112, second paragraph, as failing to comply with the enablement requirement. Applicants have submitted herewith amended claims 1 and 6 to correct their respective informalities and submit that the amended claim 1 now complies with the enablement requirement.

Also, in the Office Action, claims 1, 2, 6 - 10, and 12 are rejected under 35 U.S.C 103(a) as being unpatentable over WO 94/11105 in view of EP 0709128 A2. Additionally, claims 4 and 5 are rejected under 35 U.S.C 103(a) as being unpatentable over WO '105 in view of EP '128 A2, and further in view of US Patent No. 4,863,489 to Suggitt. Moreover, claim 3 is rejected under 35 U.S.C 103(a) as being unpatentable over WO '105 in view of EP '128 A2, as applied to claims 1, 2, 6 - 10, and 12, and further in view of US Patent No. 4,138,231 to Hedenas et al. Furthermore, claim 11 is rejected under 35 U.S.C 103(a) as being unpatentable over WO '105 in view of EP '128 A2, as applied to claims 1, 2, 6 - 10, and 12, and further in view of US Patent No. 4,364,915 to Proctor. Additionally, claims 1, 2, 6 - 10, and 12 are rejected under 35 U.S.C 103(a) as being unpatentable over WO 94/11105 in view of US Patent No. 6,214,304 to Rosenthal et al. Also, claims 4 and 5 are rejected under 35 U.S.C 103(a)

as being unpatentable over WO '105 in view of EP '128 A2, as applied to claims 1, 2, 6 - 10, and 12, and further in view of US Patent No. 4,863,489 to Suggitt. Moreover, claim 3 is rejected under 35 U.S.C 103(a) as being unpatentable over WO '105 in view of Rosenthal et al '304, as applied to claims 1, 2, 6 - 10, and 12, and further in view of US Patent No. 4,138,231 to Hedenas et al. Furthermore, claim 11 is rejected under 35 U.S.C 103(a) as being unpatentable over WO '105 in view of Rosenthal et al '304, as applied to claims 1, 2, 6 - 10, and 12, and further in view of Proctor '915.

Applicants respectfully traverse the rejections of claims 1, 2, 6 - 10, and 12 in view of the following comments. Additionally, Applicants submit that new independent claim 13 submitted herewith patentably defines over the prior art and is allowable.

Claim 1 of the present application, as currently amended, recites a method of removing metallic mercury and ionic mercury from flue gases. The inventive method includes the steps of conveying a gas that contains sulfur dioxide, or other adequate amounts of sulfur in the form of H_2S or COS , and a gas that contains hydrogen, to a catalyzer for producing a gas G that contains elemental sulfur and hydrogen sulfide and conveying the gas G to flue gas upstream of a separator, wherein mercury in the flue gas reacts with elemental sulfur and ionic sulfur in the gas G and is separated out in the separator.

In the Office Action, it is asserted that WO '105 teaches a process where SO_2 -containing gas is reacted with hydrogen over a catalyst to form sulfur and hydrogen sulfide. The Office Action further notes, however, that WO '105 does not teach reacting the resulting sulfide and sulfur with mercury. Nonetheless, according to the Office Action, EP '128 A2 teaches that sulfur and sulfide compounds react with mercury to

form mercuric sulfide. Thus, it is asserted in the Office Action that it would have been obvious to use the product of one process - i.e., the S and sulfide compounds in WO '105 as a reactant in another process - i.e., the process where S and sulfide is used to precipitate mercury if they are similar materials and the "other process" requires the product.

WO '105 discloses a process for removing SO₂ from an SO₂-containing gas stream by catalytically reducing the SO₂ to elemental sulfur. In accordance with the process, a gas stream comprising SO₂ additionally comprises a reductor preferably substantially or completely consisting of hydrogen. The gas stream is disposed into contact with a reactor containing a sulfur resistant catalyst having at least one hydrogenation function. In the reactor, the reductor reacts with SO₂ to form elemental sulfur and water. The elemental sulfur is removed from the gas stream leaving the reactor in a sulfur condensor or, alternatively, the elemental sulfur may be removed from the gas stream by, for example, capillary condensation and absorption in, say, active carbon or alumina.

EP '128 A2 discloses an arrangement wherein an aqueous sodium tetrasulfide solution is conveyed to the flue gas immediately after a partial removal of dust from the flue gas in an electrostatic precipitator, i.e. at a relatively high temperature, and the mercury sulfide that is formed by precipitation of ionic mercury Hg²⁺⁺ and Hg⁺ and from metallic mercury Hg⁰ is thereafter separated off in a fabric filter. A scrubbing out of aqueous, gaseous noxious components such as HCl and SO₂ is subsequently effected. The sodium tetrasulfide solution is sprayed in with the aid of cold atomizing air at room temperature.

Applicants respectfully disagree with the assertion in the Office Action that it would have been obvious to use the product of the WO '105 process (the S and sulfide compounds) as a reactant in the EP '128 A2 process wherein S and sulfide is used to precipitate mercury. Instead, it is submitted that neither WO '105 nor EP '128 A2 provide any motivation for one of ordinary skill in the art to combine the disclosures of WO '105 and EP '128 A2 in the manner suggested in the Office Action. With regard initially to the absence in the WO '105 reference of any such motivation to combine, Applicants note that WO '105 provides no motivation for one of ordinary skill in the art concerning the removal of mercury from a mercury laden flue gas by contact of the flue gas with a sulfur-containing solution. WO '105 is, in contrast, directed solely to a process for removing SO₂ from an SO₂-containing gas. In fact, with respect to the elemental sulfur product which is generated by the WO '105 process, WO '105 provides no hint of the desirability of deploying the elemental sulfur product for mercury removal; instead, WO '105 discloses that this elemental sulfur product is removed from the gas stream leaving the reactor in a sulfur condensor or, alternatively, that the elemental sulfur be removed from the gas stream by, for example, capillary condensation and absorption in, say, active carbon or alumina.

WO '105, instead of hinting at the desirability of deploying the elemental sulfur for a particular purpose such as, for example, the removal of mercury, merely advises, starting at line 28, Page 2 thereof, that elemental sulfur can take many forms and cites Meyer, Chemical Reviews, Vol. 76, No. 3 (1976) for a detailed survey of the various types of elemental sulfur. It is submitted that WO '105 would be much more apt to cause one of ordinary skill in the art familiar with the Claus process or other

conventional petro-chemical processes, or otherwise having familiarity with the natural occurrence of elemental sulfur, to consider that the WO '105 reference is directed to an elemental sulfur-producing process by which the thus produced elemental sulfur is an inert mass, as opposed to being directed to an elemental sulfur-producing process by which the thus produced elemental sulfur is a reactant. For example, the mention of the S_8 form of elemental sulfur (line 31, Page 2 of WO '105), would prompt one of ordinary skill in the art to surmise that the desired WO '105 elemental sulfur product is an inert mass in that the S_8 form of elemental sulfur is comprised of a closed ring structure of 8 sulfur molecules, which is the sole stable modification of elemental sulfur under normal conditions that is fully stable in air and completely water insoluble. In view of the fact that WO '105 does not even provide any reason to one of ordinary skill in the art to apply the conventional knowledge that heating above, for example, 160°C , will break the stable and inert S_8 elemental sulfur rings and convert the elemental sulfur into high molecular S chains, or that heating above, for example, 445°C , will result in S_2 molecules in vapor, it is clear that WO '105 provides no motivation to one of ordinary skill in the art to contemplate the desirability of transforming elemental sulfur from its inert state, let alone transforming elemental sulfur from its inert state into a suitable reactant for removing mercury from a flue gas.

In view of the fact that WO '105 provides no motivation for one of ordinary skill in the art concerning the removal of mercury from a flue gas, some motivation for one of ordinary skill in the art to combine the disclosures of WO '105 and EP '128 A2 in the manner suggested in the Office Action must be found in EP '128 A2 or elsewhere in the prior art. However, EP '128 A2 itself provides no motivation for one of ordinary skill in

the art to refer to the WO '105 reference. As noted, EP '128 A2 is directed to an arrangement wherein an aqueous sodium tetrasulfide solution is conveyed to the flue gas for reaction of the sodium tetrasulfide solution with mercury in the flue gas with the mercury sulfide precipitate being subsequently removed by a separator. Since the EP '128 A2 arrangement already produces the elemental sulfur needed for its mercury removal requirements, there would be no motivation for one of ordinary skill in the art to comb the prior art to identify another arrangement for producing elemental sulfur. Even if one of ordinary skill in the art were to be motivated to modify the EP '128 A2 arrangement, it cannot be seen why one of ordinary skill in the art would seek out the WO '105 reference, which provides no hint of the desirability of removal of mercury via reaction with sulfur.

It is further submitted, in fact, that one of ordinary skill in the art would, in referring to either the WO '105 or EP '128 A2 references, be taught away from combining the respective WO '105 and EP '128 A2 arrangements. EP '128 A2 discloses the introduction of aqueous sodium tetrasulfide in both the circumstance in which the flue gas comprises the additional gaseous noxious component HCL and the circumstance in which no additional gaseous noxious components are present. In the circumstance in which the flue gas comprises the additional gaseous noxious component HCL, the H_2S from the resulting reaction: $Na_2S_4 + 2 HCL \rightarrow 3 S + H_2S + 2 NaCl$ makes available ionic sulfur S^{2-} ions for reaction with Hg^{2+} . On the other hand, in the circumstance in which the flue gas does not contain any additional gaseous noxious component HCL, the continuously present water vapor in the flue gas ensures that ionic sulfur S^{2-} ions are freed from the sodium sulfide Na_2S produced by the reaction: $Na_2S +$

3 S such that these ionic sulfur S^{2-} ions are available to react with Hg^{2++} .

While the formation of H_2S is a desirable product of the EP '128 A2 arrangement (for the purpose of making available ionic sulfur S^{2-} ions), the WO '105 process is specifically directed to suppression of the formation of H_2S . For example, Page 1 of WO '105 notes that the conventional industry process of first converting SO_2 into H_2S and thereafter converting the H_2S -containing gas stream via a Claus process into elemental sulfur is a complicated way of removing SO_2 from an SO_2 -containing gas stream, whereby WO '105 instead proposes the direct formation of elemental sulfur. Accordingly, in view of the desired formation of H_2S in the EP '128 A2 process in contrast to the suppression of H_2S in the WO '105 process, it is submitted that one of ordinary skill in the art would be taught away from combining the WO '105 and EP '128 A2 arrangements.

Moreover, even if there were some motivation in WO '105, EP '128 A2, or any other prior art to combine the WO '105 and EP '128 A2 arrangements in the manner suggested in the Office Action, which Applicants submit there is not, neither WO '105 nor EP '128 A2 would provide any guidance to one of ordinary skill in the art as to how their different arrangements could be selectively combined. Indeed, in view of the fact that the EP '128 A2 arrangement comprises an SO_2 scrubber 7 for removing SO_2 from the flue gas after the flue gas has already passed beyond the aqueous sodium tetrasulfide location, it is submitted that one of ordinary skill in the art, in endeavoring to combine the WO '105 and EP '128 A2 arrangements, would sooner be led to substitute the WO '105 SO_2 catalytic converting arrangement for the existing SO_2 scrubber 7 of the EP '128 A2 arrangement than to completely scrap the aqueous sodium tetrasulfide

mercury removal in favor of the WO '105 arrangement. However, one of ordinary skill in the art would not even be led to replace the existing SO₂ scrubber 7 of the EP '128 A2 arrangement with the WO '105 SO₂ catalytic converting arrangement, as the EP '128 A2 arrangement is already configured to provide the elemental sulfur required for its mercury removal needs.

Applicants submit that the other cited references fail to overcome the deficiencies of the WO '105 and EP '128 A2 references in that such other cited references likewise fail to provide any motivation for one of ordinary skill in the art to combine the WO '105 and EP '128 A2 references in the manner suggested in the Office Action and likewise fail to suggest or disclose how the two references can be combined.

New independent claim 13 recites a method of removing metallic mercury and ionic mercury from flue gases, the method including steps of (a) conveying a gas that contains sulfur dioxide, or other adequate amounts of sulfur in the form of H₂S or COS, and a gas that contains hydrogen, to a catalyzer for producing a gas G that contains elemental sulfur and hydrogen sulfide, (b) conveying the gas G to flue gas upstream of a separator, wherein mercury in the flue gas reacts with elemental sulfur and ionic sulfur in the gas G and is separated out in the separator and (c) diverting at a location downstream of the separator a partial stream of the flue gas containing SO₂ and conducting the partial stream of the flue gas to the catalyzer for reaction of the SO₂ in the partial stream of the flue gas with the gas containing hydrogen to produce the gas G.

Accordingly, it is submitted that the method of the present invention as recited in claim 1, as currently amended, is neither taught nor suggested by the prior art of record

and, additionally, it is submitted that claims 2 - 12, which each ultimately depend from claim 1, are also neither taught nor suggested by the prior art of record for at least the reasons as set forth with respect to claim 1. Reconsideration of the rejections of claims 1 - 12 under 35 USC Section 103(a) is therefore respectfully requested.

It is submitted that the new independent claim 13 is neither taught nor disclosed by the prior art of record.

Applicants submit that claims 1 - 13 are now in condition for allowance and early action toward that end is respectfully requested. However, should the Examiner have any further comments or suggestions, the undersigned would very much welcome a telephone call from him in order to resolve any outstanding issues and expedite placement of the application into condition for allowance.

Respectfully Submitted,



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